REDUCTION OF CHEMICAL OXYGEN DEMAND (COD) AND TOTAL SUSPENDED SOLID (TSS) LEVELS IN RUBBER WASTEWATER USING BIOSAND FILTER REACTOR WITH ACTIVATED CARBON MEDIA BASED ON THE EFFECT OF RESIDENCE TIME

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Abstract

Wastewater from the rubber industry that is not treated optimally can be one of the causes of environmental damage. Initial concentration of COD waste rubber liquid 711 mg/l and TSS 407 mg / l. Biosand Filter with activated carbon can eliminate pathogenic bacteria by passing the sand in the filter and activated carbon will absorb organic substances. This study aims to determine the effectiveness of concentration reduction, COD and TSS, using a reactor with BioSand Filter reactor dimensions used measuring 12 cm x 12 cm x 120 cm and its effect on residence time. Filter Media used are sand, gravel, pumice and activated carbon. The research variable is the residence time in the reactor (10, 30, 50, 70, and 90 minutes). Removal efficiency after being processed using Biosand Filter technology with activated carbon media lowered the concentration of COD and TSS parameters to 93% for COD and 79% for TSS. Test the effect of residence time to reduce the levels of COD and TSS is done by regression test has a value of R^2=0.7014 for COD and R^2=0.681 for TSS, with $t_{count} > t_{table}$. the results show that the residence time of rubber wastewater in the reactor affect the decrease levels of COD and TSS, and quite effective in eliminating COD and TSS parameters.

Keywords: *COD, TSS, Biosand filter-activated carbon, residence time, rubber wastewater*

Introduction

Indonesia has a very large rubber plantation land and circulates in various regions, and every year it will increase. Based on data from the Ministry of Agriculture, the national rubber plantation area at the end of 2021 it reached 3.69 million ha (Direktorat Jenderal Perkebunan, 2021). Rubber wastewater usually comes from cleaning, grinding, weakening, drying, and burn pressing activities to produce wastewater with high organic content (Sari Dewi et al, 2020). Based on testing in this study the characteristics of rubber wastewater containing COD and TSS at the inlet is 711 mg/l and 407 mg/l. Quality standards for industrial wastewater are regulation of the Minister of environment No. 5 of 2014 on wastewater quality standards. COD parameters have a maximum rate of 200 mg/l and TSS parameters maximum rate of 100 mg/l (Mayasari et al, 2020). Various rubber industries generally process liquid waste using biological treatment. But its effectiveness largely depends on the ability of its bacteria to be able to form flocks; this processing requires expensive costs and large area of land. Treatment using Biosand Filter with activated carbon can reduce organic and inorganic levels in rubber wastewater. In the

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upper layer of the media will occur biofilm growth, this layer will reduce the smell, taste and color, on waste rubber liquid. Adding this activated carbon to the BioSand filter treatment improves the efficiency of reducing organic content in wastewater and decomposing substances that have not been degraded from the BioSand Filter treatment. Research on the processing of industrial rubber wastewater with BioSand Filter Technology has been previously conducted Suligundi (2013), the results of processing with BioSand Filter and activated carbon COD efficiency of 98.33% (Suligundi, 2013), and also in Halim's research (2016) using Biosand Filter technology with activated carbon, it has the effectiveness of reducing COD levels up to 85.42% and TSS 82.65% (Halim, 2014). Based on this description, treatment for rubber liquid waste is chosen using Biosand Filter reactor with activated carbon, so that it can be known the efficiency of estimating COD and TSS levels in rubber liquid waste, and the influence of variations in residence time in reducing the concentration of COD and TSS in rubber liquid waste.

So that the removal efficiency of COD, TSS levels in rubber wastewater and the influence of variations in residence time in reducing the concentration of COD and TSS in rubber wastewater can be calculated.

Research Methodology

Scope and Design

This research's scope and design includes:

1. Rubber liquid waste samples were taken from the inlet of WWTP PTPN VII Lampung.
2. Preparations of sand, pumice, activated carbon, and gravel media by washing, drying and activation of media.
3. The height of the sand filter media is 50 cm, pumice stone 10 cm, activated carbon 20 cm and Gravel 10 cm and the total height of the media is 90 cm.
4. Biofilm formation was observed physically and isolated microorganisms to determine the formation of biofilms.
5. Variations of residence time used 10, 30, 50, 70, 90 minutes.

Material

a. Rubber Industry Wastewater

Rubber is currently widely produced synthetically, as a raw material for rubber, latex that can be made in a bowl container taken by grinding the bark of the rubber tree so that it will remove the thick liquid from the gutter and then be accommodated for later processing (Nuraini et al, 2019). Many rubber exports in Indonesia are provided in the form of crumb rubber which has been included in the Indonesian rubber standard (SIR). There are two products of crumb rubber, namely high grade, made from latex raw materials, and low grade produced from Felts (Sari Dewi et al, 2020).

The wastewater parameters of the rubber industry consist of physical and chemical parameters. Physical parameters include total suspended solids (TSS), temperature, turbidity, odor, and color. Chemical parameters consist of acid (pH), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and ammonia (NH_3).

b. Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) is the total oxygen required for a chemical compound in a reaction to be able to oxidize all organic matter contained in water (Rahmat and Mallongi, 2018). Rubber processing waste at the inlet has a COD concentration in liquid waste 120-15069 mg/l (Nasrullah et al, 2014). Determining COD concentration's value in water is done by reacting it with potassium dichromate as an oxidizer or reagent (Atima, 2015) (Nugroho et al, 2017).

c. Total Suspended Solid (TSS)

Total Suspended Solid (TSS) is the content in water consisting of solid substances (sand, clay, mud, etc.) or suspended particles (phytoplankton, zooplankton, bacteria, fungi), and also the rest of dead microorganisms. Waste water rubber industry has a concentration of TSS 30 - 525 mg / l (Nasrullah et al, 2014). The brightness in water depends on the color and turbidity. High concentrations of TSS will inhibit the entry of sunlight for photosynthesis, so the content and dissolved oxygen needed by plants will decrease. The decreasing oxygen content causes the ecosystem in the water to be disrupted (Nuraini et al, 2019).

d. Biosand Filter

Biosand filter in principle is the development of a slow sand filter that is processing by flowing water on the media to remove pathogenic bacteria by flowing water by gravity through the filter media. Pollutants in the water are then retained and absorbed into the pores of the filter media this process can remove suspended particles and also dissolved in wastewater. Microorganisms and solid particles floating in the upper layer of the media when left at a certain time in the topmost sand layer will form a biofilm (Suligundi, 2013). Biosand filters in processing generally only use fine sand media, coarse sand and gravel. The addition of filter media is done to get maximum processing results with pumice media and the addition of activated carbon. The function of fine sand in the upper layer is for the initial filter that can hold solid particles in wastewater in large quantities, while for coarse sand, gravel, pumice media serves to buffer the media from the previous filter. Activated Carbon is used as an addition to the BioSand Filter to improve the efficiency of reducing dissolved organic matter content in liquid waste.

e. Residence Time

Residence time is the time required to carry out a treatment process in a reactor used under certain conditions (Ratnawati and Al Kholil, 2005), residence time is also a concept to express how fast a fluid that moves, through a system in equilibrium and consumes a substance in a certain space, such as a reservoir or reactor. The residence time is not only related to hydraulic but also the residence time of bacteria (Kencanawati, 2016). The longer the residence time of a fluid in the reactor will make the removal of substances greater, so as to set aside organic and inorganic compounds to the maximum

Methods

a. Research Variables

1. Independent Variable

Independent variables contained in this study are: variations in residence time (10, 30, 50, 70, 90 minutes).

2. Dependent Variable

The dependent variable contained in the test is the concentrations of the parameters studied are COD and TSS.

b. Procedure

1. Media Preparation

Media washed, then dried, for the activation of carbon using chemicals as activators that is by using a basic solution of NaOH. then the carbon is soaked for 24 hours. wash using aquadest until the pH of the activated carbon washing water is neutral.. Activated Carbon is filtered and dried in an oven at 105o C for 2 hours. Activated charcoal is then in the wind until it reaches room temperature (Primasari et al, 2020). Once all the substrate is ready, prepared by height.

2. Biofilm

Biofilm formation is done by immersing the reactor with waste water until at a certain time a slimy layer is formed with the water level in the reactor kept 5 cm above the topmost media by paying attention. speed between inlet and outlet faucets. This height is set so that the biofilm layer is not easily damaged and still maintain the life of microorganisms in the biofilm layer (Jin et al, 2021), (Harahap et al, 2020). Biofilm layer formed on the sand media can be observed visually with a slippery layer such as mucus and the color of the sand surface layer will change from the initial light yellow color to brown color based on previous researchers this is a sign that there has been activity of microorganisms on the biofilm. The formation of biofilms can also be observed by isolating microorganisms to see what colonies of microorganisms contained in the biofilm layer after the biofilm layer grows (Srimurni, 2016), (BSN, 2004).

3. Data Analysis
Data analysis for the test results by descriptive analysis, and a linier regression test to know whether the variables affect each other.

Results and Discussion

Characteristics of Waste Rubber

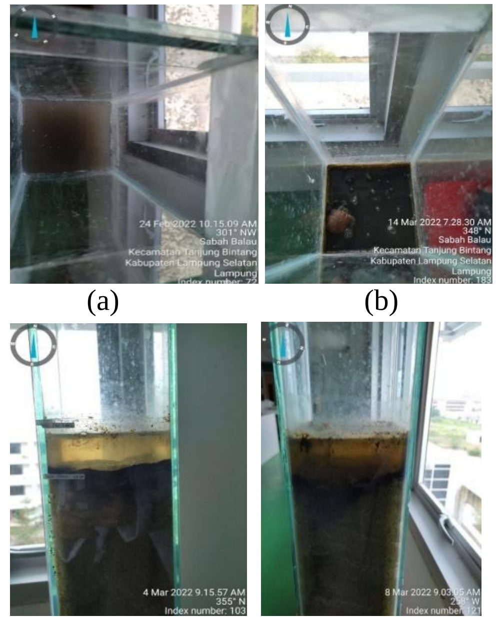
Preliminary test of COD concentration, and TSS with 3 repetitions obtained an average of 436 mg/l, and 711 mg/l, respectively.

Table 1. Characteristics of wastewate

Parameters (mg/l)	Results	Quality Standard
TSS	436	100 mg/l
COD	711	200 mg/l

Biofilm Formation

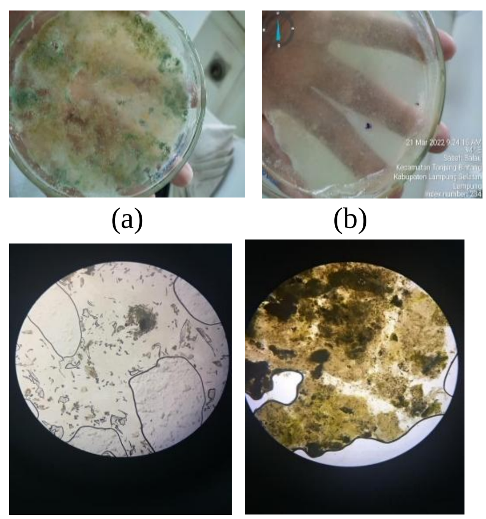
Biofilm growth process in this study formed up to 15 days. Biofilms were grown by immersing the media in a BioSand filter reactor with activated carbon media with a sample of rubber wastewater, with the water level maintained 5 cm above the sand media. Biofilm formation on the surface of the water until the 7th day there is still a small number of bubbles. On the 10th day, a film has formed. On 15th day already seen changes characterized by the formation of mucus at the top of the brown as the end of the formation of biofilm when the formation of factors that are considered are temperature, pH and nutrients.



(a) (b)

(b) (d)

Figure 1. Biofilm growth on water surface (a). Day-1 (b). Day-15 with the addition of sugar, (c) front view (d) side view



(a) (b)

(c) (d)

Figure 2 . Observation of microorganisms on biofilms
(a). PDA media observation, (b) NA Media observation,
(c,d) observation microscope magnification *40x dan 100×*

To determine the presence of microorganisms in the biofilm layer is to isolate bacteria and fungi using NA and PDA media. Then observation with a microscope to see microorganisms on the biofilm layer.

Amount of fungal content in biofilms more than bacteria because the layer taken to be tested is the dominant top layer consisting of fungi. Fungi contain extracellular enzymes to be able to decompose complex compounds in water (Atima, 2015). Microscope observations were also carried out on the biofilm layer contained in the upper layer of sand and from the observations in the Figure (c-d) can be seen the presence of microorganisms such as bacteria and protozoa.

Analysis of cod and TSS levels reduction efficiency

Reduction COD levels

Processing with COD concentration 711 mg/l has an removal efficiency of COD levels reached 93% which is reinforced by research Bonifasia (2013) and Yuni lestari (2014) the efficiency of cod with BioSand Filter technology with activated carbon reaches 65% - 98,33% (Suligundi, 2013), (Yadav et al, 2018). rubber wastewater treatment has an optimum point at the 70 minute. Rubber wastewater treatment without biofilm has COD removal efficiency reached 68% in the 70 minute and COD levels and increased again in the 90 minute

Based on the results of processing carried out in the absence of biofilm, only applying adsorption with filter media in the reactor has not met the quality standards for COD parameters according to regulations and from these results it can be concluded that biofilm serves to degrade organic levels in water (Fadhillah and Wahyuni, 2016).The efficiency of reduce COD levels continues to reduce over time which indicates the filter media has reached the optimum point so that it is necessary to wash the media again this is in accordance with the Sulistyanti experiment (2018) controlled flow velocity at a point will occur decrease back after reaching the optimum point to decompose organic compounds in wastewater (Ramdja et al, 2008).

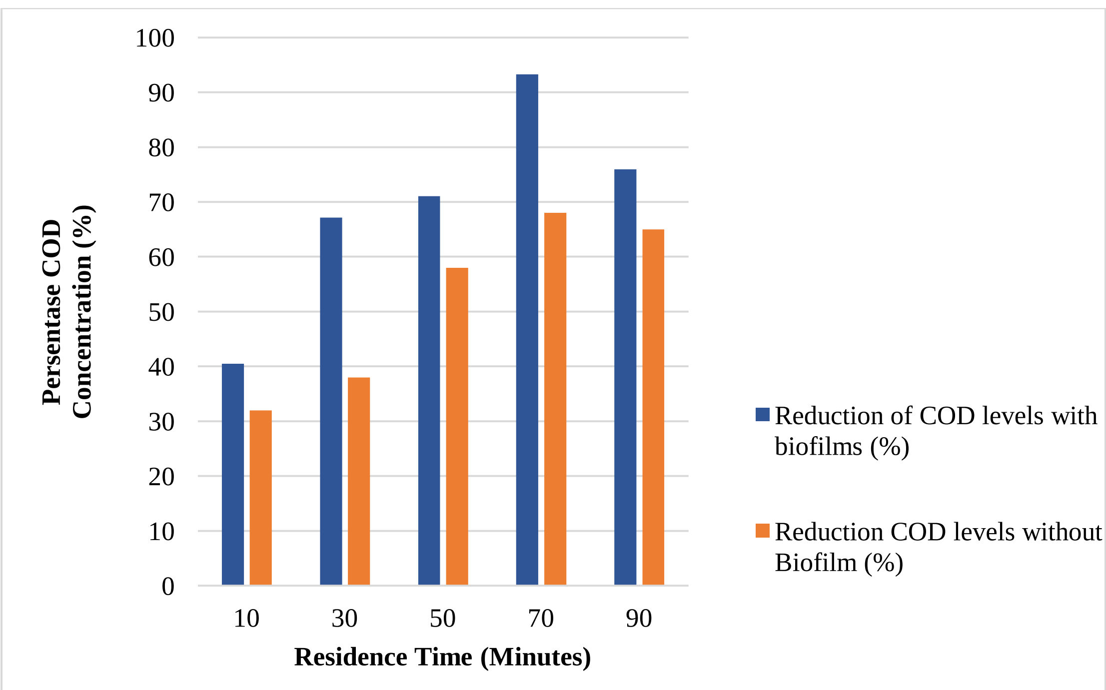


Figure 3. COD reduction percentage

Reduction TSS levels

TSS concentration of 407 mg/l, has efficiency removal of TSS levels reached 79% in the 70 minute so that the treatment of rubber wastewater has an optimum point in the 70 minute. Rubber wastewater treatment without biofilm has an efficiency of removal of TSS levels reached 70% in the 70 minute and TSS levels increased again in the 90 minute. The efficiency of reducing TSS levels by processing using biofilm is higher than processing without biofilm, due to the presence of microorganisms that can reduce the levels of organic and suspended solids in rubber wastewater. Processing without using biofilm TSS levels have not met the quality standards for TSS parameters so that additional processing is required. The Re-increase in TSS concentration in the 90 minute of processing is caused by TSS that occurs in rubber wastewater containing suspended particles.

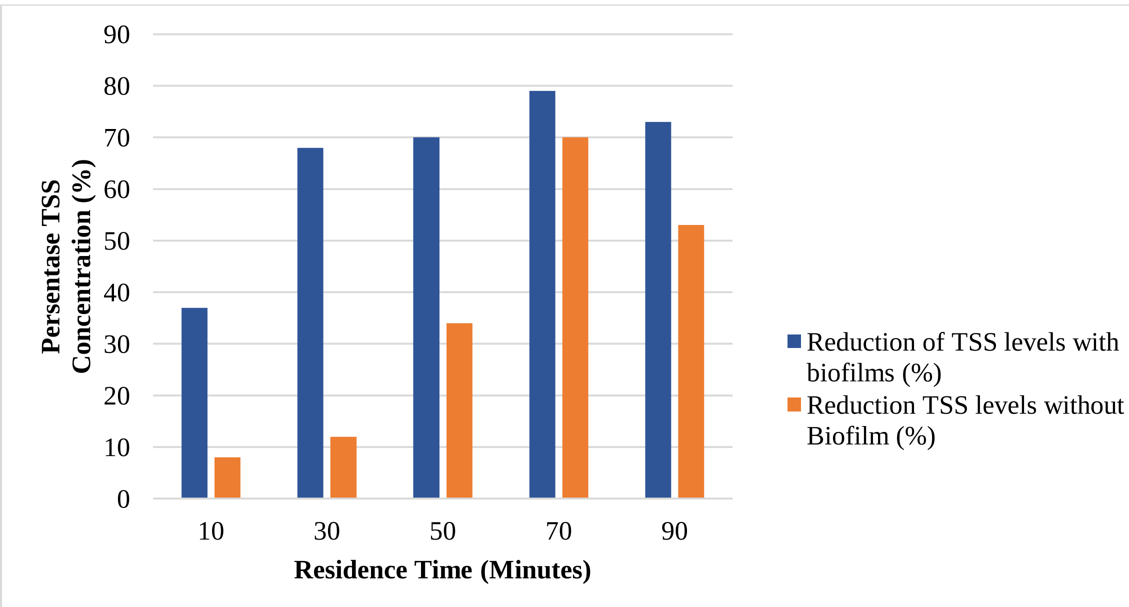


Figure 4. TSS reduction percentage

Analysis the effect of variation residence time on the reduction of COD and TSS levels

Analysis the effect of variation residence time to reduce COD levels

Regression analysis of the variation residence time to reduce COD levels resulted in the value of R2 or coefficient of determination of 0.7014 means that the variation of residence time to reduce COD levels of liquid rubber waste 70.14% and the remaining 29.86% are influenced by variables that are not discussed. P value<0.05 that is 0.037 indicates that the regression line equation is significant. Based on statistical results using Jamovi can be seen that the value of t count is 3.07 is greater than the T table with the level of significance allowed %. The value of T table is 2.772 hence the decision is to reject the null hypothesis. The value of t with a negative sign that explains the existence of a counter-directional relationship between residence time and COD levels. So it can be concluded that the true residence time affect COD levels.

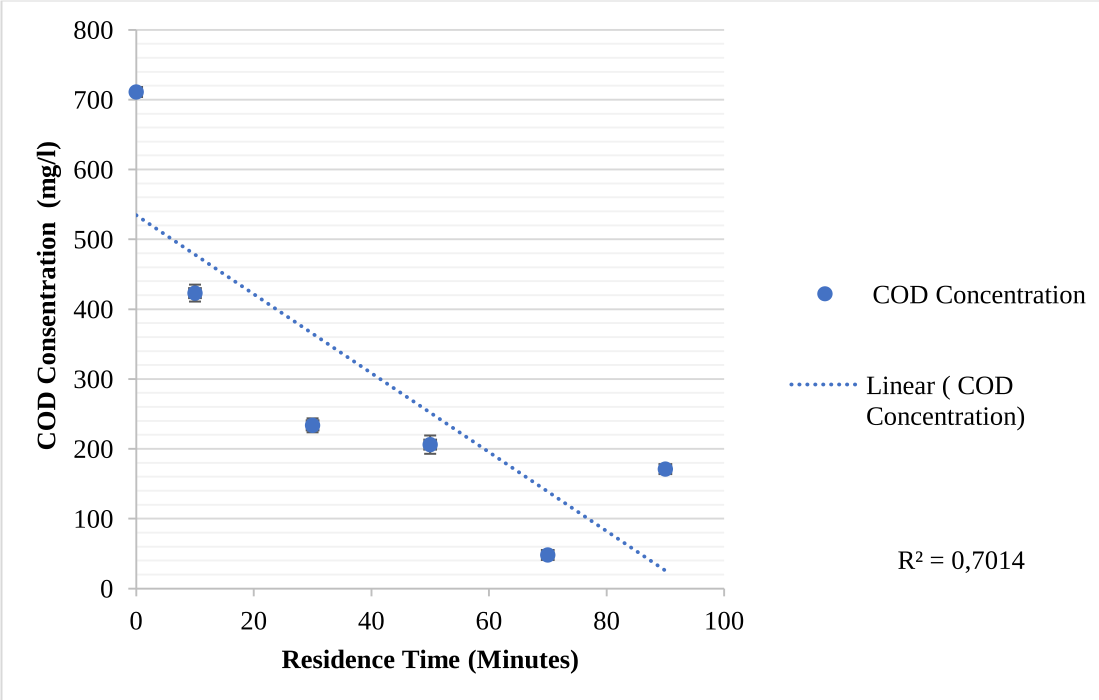


Figure 5 Regression analysis effect of variation residence time to reduction COD levels

Analysis the effect variation of residence time to reduce TSS levels

Regression analysis of variations in residence time to reduce TSS levels resulted in the value of R2= 0.681 means that variations in residence time affect the reduce TSS levels to 68.1% and 31.2% are influenced by other variables that are not discussed. P value<0.05 that is 0.043 indicates that the regression line equation is significant. Based on statistical results using Jamovi t value results calculate the test results are 2.92 greater than T table with a significance level of 5%. The value of T table is 2.772 so the decision is to reject the null hypothesis. The negative sign for the calculated t value illustrates the opposite relationship, and it can be concluded that the residence time has an effect on the reduction of TSS levels. The dwell time has the most optimum reduce at the 70 minute. From the results of testing the treatment of rubber wastewater using a BioSand filter reactor with Activated Carbon, the results showed that the residence time of rubber wastewater in the reactor has an effect to reduce the levels of COD and TSS with a negative X-marked value which explains the relationship in the opposite direction.

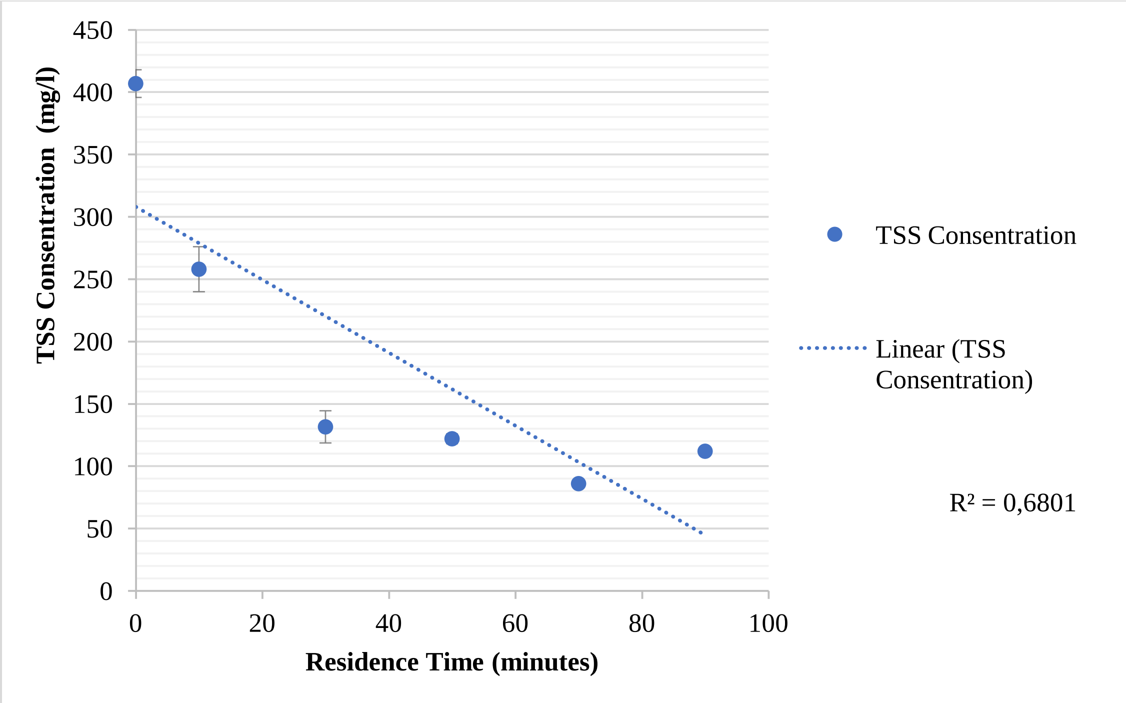


Figure 6. Regression analysis effect of variation residence time to reduction TSS levels

Conclusions

Based on the research of COD and TSS reduction in rubber wastewater with BioSand Filter with activated carbon media, concludes that:

1. Reduction of COD and TSS levels of rubber wastewater using BioSand filter reactor with activated carbon media based on the variation of residence time has the highest efficiency in the 70th minute of 93% and 79% respectively.

2. Residence time effect on reduce COD and TSS levels, based on a simple regression test of reduce COD and TSS levels in rubber wastewater with variations in residence time has a value of $R2= 0.7014$ for COD and $R2= 0.681$ for TSS, the value of t count obtained is greater than t the table shows the influence reduce COD and TSS

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